

BIDIRECTIONAL STRETCH MATERIAL AND LAMINATE MADE THEREFROM
APPLICATIONS THEREOF, AND METHODS OF MAKING SAME

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RELATED APPLICATIONS

This Application is a continuation-in-part of and claims priority from Attorney Docket Number 18,169.1 - U.S. Patent Application bearing Express Mailing Number EV413564267US filed December 17, 2003 for Stretchable Film Laminates and Methods
10 and Apparatus for Making Stretchable Film Laminates in the names of Leslie Warren Collier, IV, Susan Elaine Shawver, Bryon Paul Day, Raymond Jeffrey May, James Russell Fitts, Jr., Michael Tod Morman, Monica Varriale, Matthew Boyd Lake, David Michael Matela, Gregory Todd Sudduth, Randall James Palmer, Charles John Morell, Prasad Shrikrishna Potnis, Rasha Wafik Zaki Guirguis, Cristian M. Neculescu, and Peiguang
15 Zhou. The foregoing application is incorporated by reference herein in its entirety.

FIELD OF THE INVENTION

The present invention relates to bidirectional stretch film and netting fabric
20 materials and methods of making the same.

BACKGROUND OF THE INVENTION

Nonwoven and film-based fabric materials have been heretofore utilized as base
25 materials in a variety of personal care products (such as infant, child, elder, and feminine care products) as well as in workwear, outerwear and even outdoor protective covering materials. For instance, nonwoven materials have been used as base materials for diaper and training pant liners, outercovers, and absorbent components. Such materials have
likewise been used as components for surgical drapes and gowns, surgical masks, and
30 protective covers such as grill, car and boat covers, as well as veterinary care products. While a variety of nonwoven and film-based materials have been conceived for use with such products, there is still a need for materials that provide for bidirectional stretch properties, and that will allow for fluid transfer. By bidirectional stretch, it is meant that such materials are capable of elongation/extensibility in at least two different directions,
35 and in some circumstances, stretch and recovery (elastic in nature) in at least the two different directions. There is a further need for such materials which demonstrate corrugated surface topography for a cloth-like feel.

There is a further need for such bidirectional stretch materials that can be readily produced in-line without complicated manufacturing steps. There is also a further need for laminates which incorporate such materials and methods of making such materials.

Heretofore it is known to produce scrim and netting-type fabric materials from polymer resins. Such materials have found applications in a wide array of products, such as in containment products, such as produce bags, and as separation layers. Such materials offer the possibility of bidirectional stretch as a result of their particular structural geometry. The nature of flexible netting allows for "give" in multiple directions, and in some instances directions perpendicular to each other. However, while such materials have been produced through a number of processes, there is still a need for in-line manufacturing processes for such netting materials, that allow them to be easily/rapidly produced and laminated to various other nonwoven materials, for a variety of end product uses. It is to such needs that the current invention is directed.

SUMMARY OF THE INVENTION

A method of producing a laminate material includes the steps of extruding or providing a thermoplastic film; forming a pattern of shapes defined by thin and thick areas in the film; exposing the film to heat while the film is under tension, such that the heat causes polymer within the film to flow from the thin areas to the thick areas, thereby creating a pattern of open spaces within the film; and bonding the film to at least one nonwoven material, whereby a netting and nonwoven material laminate is formed.

A method of producing a bidirectional stretch material is also provided which includes the steps of extruding or providing a thermoplastic film; forming a pattern of closed shapes within the film, such that there are thicker and thinner areas in the film, corresponding to the pattern; and bonding the patterned film to a sheet material that is extensible in at least two directions so as to create a film and nonwoven material laminate with bidirectional stretch.

A method of producing a stretch material also includes the steps of extruding or providing a thermoplastic film; forming a pattern of closed shapes within the film, such that there are thicker and thinner areas in the film, corresponding to the pattern; exposing the patterned film to heat while the film is under tension, such that the heat causes polymer within the film to flow from the thin areas to the thick areas, thereby creating a pattern of open spaces within the film; such that a netting material is formed; and bonding the netting material to a sheet material, while the netting is being stretched or is under

tension. In one embodiment of the method, the sheet material is a nonwoven web. In a further embodiment of the method, the nonwoven web is a necked nonwoven web.

5 A method of producing a stretch material also includes the steps of extruding a thermoplastic film; passing the extruded film through a nip of two rolls having first and second roll surfaces, where the first roll surface includes a raised closed shape pattern and the second roll surface is a flat anvil surface; forming a pattern in the film with the rolls, while chilling the film, such that there are thicker and thinner areas in the film, corresponding to the pattern on the first roll surface; and passing the patterned film under
10 tension, by a heated air stream, whereby the polymer in the thinner patterned areas is removed, thereby creating a netting material. A bidirectional stretch laminate is produced by bonding a necked nonwoven material to the netting material while the netting material is being stretched (under tension).

15 A method of producing a stretch material includes the steps of extruding or providing a thermoplastic film; forming a pattern of closed shapes within the film, such that there are thicker and thinner areas in the film, corresponding to the pattern; and bonding the patterned film to a sheet material that is extensible in at least one direction so as to create a film and nonwoven material laminate with stretch in at least one direction.

20 Materials may also be produced which include a topographed film and nonwoven laminate, or alternatively, a netting and nonwoven material laminate. Such topographed film, netting and laminates may be nonextensible, extensible in one direction, extensible to two directions, elastic in one direction, or elastic in two directions, depending on the product needs. Such laminates may be corrugated to provide cloth-like texture. Films, netting materials and laminates of the above constructions and produced by the above methods are all considered to be within the scope of the invention.

25 BRIEF DESCRIPTION OF THE DRAWINGS

30 The invention will be better understood by reference to the following description of embodiments of the invention taken in conjunction with the accompanying drawings, wherein:

FIG. 1 illustrates a method of making the materials of the invention.

35 FIG. 2 illustrates a perspective/cross sectional view of film material made in accordance with the invention.

FIG. 2A illustrates a perspective/cross-sectional view of laminate material made in accordance with the invention.

5 FIG. 3A illustrates an alternative embodiment of a pattern roll that may be used to make material (also shown) with a plain/flat anvil roll, in accordance with the invention.

FIG. 3B illustrates an alternative embodiment of a pattern roll that may be used to make material with a plain anvil roll, in accordance with the invention.

10 FIG. 3C illustrates an alternative embodiment of a pattern roll that may be used to make material with a plain anvil roll, in accordance with the invention.

15 FIG. 3D illustrates an alternative embodiment of a pattern roll that may be used to make material, in accordance with the invention.

FIG. 3E illustrates an alternative embodiment of a pattern roll that may be used to make material, in accordance with the invention.

20 Fig. 4 illustrates a top view/partial sectional view of a diaper showing use of various components therein made of a material according to the present invention.

DETAILED DESCRIPTION OF THE INVENTION

25 Definitions:

As used herein, the term "personal care product" means diapers, training pants, swimwear, absorbent underpants, adult incontinence products, and feminine hygiene products, such as feminine care pads, napkins and pantliners. While a diaper is
30 illustrated in Figure 4, it should be recognized that the inventive material may just as easily be incorporated into any of the previously listed personal care products or alternative product uses as a liquid transfer layer, an extensible layer or an elastic layer. Additionally, such material may be utilized as a structural component of other home care and commercial products, such as in water or air filtration systems, mortuary and
35 veterinary products.

As used herein the term "protective outer wear" means garments used for protection in the workplace, such as surgical gowns, hospital gowns, face masks, and protective coveralls.

As used herein, the terms "protective cover" and "protective outer cover" shall be used synonymously and shall mean covers that are used to protect objects such as for example car, boat and barbeque grill covers, as well as agricultural fabrics.

As used herein, the terms "polymer" and "polymeric" when used without descriptive modifiers, generally include but are not limited to, homopolymers, copolymers, such as for example, block, graft, random and alternating copolymers, terpolymers, etc., and blends and modifications thereof. Furthermore, unless otherwise specifically limited, the term "polymer" includes all possible spatial configurations of the molecule. These configurations include, but are not limited to isotactic, syndiotactic and random symmetries.

As used herein, the terms "machine direction" or MD means the direction along the length of a fabric in the direction in which it is produced. The terms "cross machine direction," "cross directional," or CD mean the direction across the width of fabric, i.e. a direction generally perpendicular to the MD.

As used herein, the term "nonwoven web" means a polymeric web having a structure of individual fibers or threads which are interlaid, but not in an identifiable, repeating manner. Nonwoven webs have been, in the past, formed by a variety of processes such as, for example, meltblowing processes, spunbonding processes, hydroentangling, air-laid and bonded carded web processes.

As used herein, the term "bonded carded webs" refers to webs that are made from staple fibers which are usually purchased in bales. The bales are placed in a fiberizing unit/picker which separates the fibers. Next, the fibers are sent through a combining or carding unit which further breaks apart and aligns the staple fibers in the machine direction so as to form a machine direction-oriented fibrous non-woven web. Once the web has been formed, it is then bonded by one or more of several bonding methods. One bonding method is powder bonding wherein a powdered adhesive is distributed throughout the web and then activated, usually by heating the web and adhesive with hot air. Another bonding method is pattern or thermal point bonding wherein heated calender rolls or ultrasonic bonding equipment is used to bond the fibers together, usually in a localized bond pattern through the web and / or alternatively the web may be bonded across its entire surface if so desired. When using bicomponent staple fibers, through-air bonding equipment is, for many applications, especially advantageous.

As used herein the term "spunbond" refers to small diameter fibers which are formed by extruding molten thermoplastic material as filaments from a plurality of fine, usually circular capillaries of a spinneret with the diameter of the extruded filaments being rapidly reduced as by for example in U.S. Pat. No. 4,340,563 to Appel et al., and U.S. Pat. No. 3,692,618 to Dorschner et al., U.S. Pat. No. 3,802,817 to Matsuki et al., U.S. Pat. Nos. 3,338,992 and 3,341,394 to Kinney, U.S. Pat. No. 3,542,615 to Dobo et al., which are each incorporated by reference in their entirety herein.

As used herein, the term "meltblown" means fibers formed by extruding a molten thermoplastic material through a plurality of fine, usually circular die capillaries as molten threads or filaments into converging high velocity gas (e.g. air) streams which attenuate the filaments of molten thermoplastic material to reduce their diameter, which may be to microfiber diameter. Thereafter, the meltblown fibers are carried by the high velocity gas stream and are deposited on a collecting surface to form a web of randomly dispersed meltblown fibers. Such a process is disclosed, in various patents and publications, including NRL Report 4364, "Manufacture of Super-Fine Organic Fibers" by B. A. Wendt, E. L. Boone and D.D. Fluharty; NRL Report 5265, "An Improved Device For The Formation of Super-Fine Thermoplastic Fibers" by K.D. Lawrence, R. T. Lukas, J. A. Young; and U.S. Patent No. 3,849,241, issued November 19, 1974, to Butin, et al.

As used herein, the terms "sheet" and "sheet material" shall be used interchangeably and in the absence of a word modifier, refer to woven fabric materials, nonwoven fabric webs, polymeric films, polymeric scrim-like materials, and polymeric foam sheeting.

The basis weight of nonwoven fabrics or films may be expressed in ounces of material per square yard (osy) or grams per square meter (g/m^2 or gsm) and the fiber diameters useful are usually expressed in microns. (Note that to convert from osy to gsm, multiply osy by 33.91). Film gauges may also be expressed in microns or mils.

As used herein, the term "laminate" refers to a composite structure of two or more sheet material layers that have been adhered through a bonding step, such as through adhesive bonding, thermal bonding, point bonding, pressure bonding, extrusion coating or ultrasonic bonding.

To "neck" or be "necked" refers to a process of tensioning a fabric in a particular direction thereby reducing the dimension of the fabric in the direction perpendicular to the direction of tension. For example, tensioning a nonwoven fabric in the MD causes the fabric to "neck" or narrow in the CD and give the necked fabric CD stretchability. When the tensioning force is removed, the material can be pulled back to its original dimension (in the direction perpendicular to the direction of tension). A necked material generally has a higher

basis weight per unit area than the unnecked material. Examples of such extensible and/or elastic fabrics include, but are not limited to, those described in U.S. Patent Nos. 4,965,122 to Morman et al. and 5,336,545 to Morman et al. each of which is incorporated by reference herein in its entirety.

5 “Neck bonding” refers to the process wherein an elastic member is bonded to a non-elastic member while only the non-elastic member is extended or necked so as to reduce its dimension in the direction orthogonal to the extension. “Neck bonded laminate” refers to a composite elastic material made according to the neck bonding process, i.e., the layers are joined together when only the non-elastic layer is in an extended condition.
10 Such laminates usually have cross directional stretch properties. Further examples of neck-bonded laminates are those described in U.S. Patent Nos. 5,226,992, 4,981,747 to Morman and U.S. Patent No. 5,514,470 to Haffner et al., each of which are incorporated by reference herein in their entirety. For example a nonwoven web, such as a spunbond web, may be necked between about 20 and 60 percent and then attached to an elastic
15 layer. In such an instance, such elastic layer could then demonstrate CD extensibility with the nonwoven facing layer attached.

 “Neck-stretch bonding” generally refers to a process wherein an elastic member is bonded to another member while the elastic member is in an extended condition (under tension) and the other layer is a necked, non-elastic layer. “Neck-stretch bonded
20 laminate” refers to a composite elastic material made according to the neck-stretch bonding process, i.e., the layers are joined together when both layers are in an extended condition and then allowed to relax. Such laminates usually have omni-directional or multi directional stretch properties.

 As used herein, the term “elastomeric” shall be interchangeable with the term
25 “elastic” and refers to sheet material which, upon application of a stretching force, is stretchable in at least one direction (such as the CD or MD direction), and which upon release of the stretching force contracts/returns to approximately its original dimension. For example, a stretched material having a stretched length which is at least 50 percent greater than its relaxed unstretched length, and which will recover to within at least 50
30 percent of its stretched length upon release of the stretching force. A hypothetical example would be a one (1) inch sample of a material which is stretchable to at least 1.50 inches and which, upon release of the stretching force, will recover to a length of not more than 1.25 inches. Desirably, such elastomeric sheet contracts or recovers up to 50 percent of the stretch length in the cross machine direction. Even more desirably, such elastomeric
35 sheet material recovers up to 80 percent of the stretch length in the cross machine direction. Even more desirably, such elastomeric sheet material recovers greater than 80

percent of the stretch length in the cross machine direction. Desirably, such elastomeric sheet is stretchable and recoverable in both the MD and CD directions.

As used herein, the term "elastomer" shall refer to a polymer which is elastomeric.

As used herein, the term "thermoplastic" shall refer to a polymer which is capable
5 of being melt processed.

As used herein, the term "inelastic" or "nonelastic" refers to any material which does not fall within the definition of "elastic" above.

As used herein, the term "multilayer laminate" means a laminate including a variety of different sheet materials. For instance, a multilayer laminate may include some layers
10 of spunbond and some meltblown such as a spunbond/meltblown/spunbond (SMS) laminate and others as disclosed in U.S. Patent 4,041,203 to Brock et al., U.S. Patent 5,169,706 to Collier, et al., U.S. Patent 5,145,727 to Potts et al., U.S. Patent 5,178,931 to Perkins et al., and U.S. Patent 5,188,885 to Timmons et al., each incorporated herein by reference in its entirety. Such a laminate may be made by sequentially depositing onto a
15 moving forming belt first a spunbond fabric layer, then a meltblown fabric layer and last another spunbond layer and then bonding the laminate, such as by thermal point bonding. Alternatively, the fabric layers may be made individually, collected in rolls, and combined in a separate bonding step or steps. Multilayer laminates may also have various numbers of meltblown layers or multiple spunbond layers in many different configurations and may
20 include other materials like films (F) or coform materials, e.g. SMMS, SM, SFS.

As used herein, the term "coform" means a process in which at least one meltblown diehead is arranged near a chute through which other materials are added to the web while it is forming. Such other materials may be pulp, superabsorbent particles, cellulose or staple fibers, for example. Coform processes are shown in U.S. Patents
25 4,818,464 to Lau and 4,100,324 to Anderson et al., each incorporated herein by reference in its entirety.

As used herein, the term "conjugate fibers" refers to fibers which have been formed from at least two polymers extruded from separate extruders but spun together to form one fiber. Conjugate fibers are also sometimes referred to as multicomponent or
30 bicomponent fibers. The polymers are usually different from each other though conjugate fibers may be monocomponent fibers. The polymers are arranged in substantially constantly positioned distinct zones across the cross-section of the conjugate fibers and extend continuously along the length of the conjugate fibers. The configuration of such conjugate fiber may be, for example, a sheath/core arrangement wherein one polymer is
35 surrounded by another or may be a side by side arrangement, a pie arrangement or an "islands-in-the-sea" arrangement. Conjugate fibers are taught in U.S. Patent 5,108,820 to

Kaneko et al., U.S. Patent 4,795,668 to Krueger et al., and U.S. Patent 5,336,552 to Strack et al. Conjugate fibers are also taught in U.S. Patent 5,382,400 to Pike et al., and may be used to produce crimp in the fibers by using the differential rates of expansion and contraction of the two or more polymers. For two component fibers, the polymers may be present in varying desired ratios. The fibers may also have shapes such as those described in U.S. Patents 5,277,976 to Hogle et al., U.S. Patent 5,466,410 to Hills and U.S. Patents 5,069,970 and 5,057,368 to Largman et al., which describe fibers with unconventional shapes. Each of the foregoing patents is each incorporated herein by reference hereto, in its entirety.

As used herein the term "thermal point bonding" involves passing a fabric or web of fibers to be bonded between a heated calender roll and an anvil roll. The calender roll is usually, though not always, patterned in some way so that the entire fabric is not bonded across its entire surface, and the anvil roll is usually flat. As a result, various patterns for calender rolls have been developed for functional as well as aesthetic reasons. One example of a pattern has points and is the Hansen Pennings or "H&P" pattern with about a 30% bond area with about 200 bonds/square inch as taught in U.S. Patent 3,855,046 to Hansen and Pennings, incorporated herein by reference in its entirety. The H&P pattern has square point or pin bonding areas wherein each pin has a side dimension of 0.038 inches (0.965 mm), a spacing of 0.070 inches (1.778 mm) between pins, and a depth of bonding of 0.023 inches (0.584 mm). The resulting pattern has a bonded area of about 29.5%. Another typical point bonding pattern is the expanded Hansen Pennings or "EHP" bond pattern which produces a 15% bond area with a square pin having a side dimension of 0.037 inches (0.94 mm), a pin spacing of 0.097 inches (2.464 mm) and a depth of 0.039 inches (0.991 mm). Another typical point bonding pattern designated "714" has square pin bonding areas wherein each pin has a side dimension of 0.023 inches, a spacing of 0.062 inches (1.575 mm) between pins, and a depth of bonding of 0.033 inches (0.838 mm). The resulting pattern has a bonded area of about 15%. Yet another common pattern is the C-Star pattern which has a bond area of about 16.9%. The C-Star pattern has a cross-directional bar or "corduroy" design interrupted by shooting stars. Other common patterns include a diamond pattern with repeating and slightly offset diamonds with about a 16% bond area and a wire weave pattern looking as the name suggests, e.g. like a window screen pattern having a bond area in the range of from about 15% to about 21% and about 302 bonds per square inch. The depth of such a pattern in an embodiment may range from between about 0.020 inch to 0.050 inch.

Typically, the percent bonding area varies from around 10% to around 30% of the area of the fabric laminate. As is well known in the art, the spot bonding holds the laminate

layers together as well as imparts integrity to each individual layer by bonding filaments and/or fibers within each layer.

As used herein, the term "ultrasonic bonding" means a process performed, for example, by passing the fabric between a sonic horn and anvil roll as illustrated in U.S. Patent 4,374,888 to Bornslaeger, incorporated by reference herein in its entirety.

As used herein, the term "adhesive bonding" means a bonding process which forms a bond by application of an adhesive. Such application of adhesive may be by various processes such as slot coating, spray coating and other topical applications. Further, such adhesive may be applied within a product component and then exposed to pressure such that contact of a second product component with the adhesive containing product component forms an adhesive bond between the two components.

As used herein, and in the claims, the term "comprising" is inclusive or open-ended and does not exclude additional unrecited elements, compositional components, or method steps. Accordingly, such term is intended to be synonymous with the words "has", "have", "having", "includes", "including", and any derivatives of these words.

As used herein, the terms "extensible", "extendable", or "expandable" mean elongatable in at least one direction, but not necessarily recoverable.

Unless otherwise indicated, percentages of components in formulations are by weight.

"Stretch-to-stop" refers to a ratio determined from the difference between the unextended dimension of a stretchable laminate and the maximum extended dimension of a stretchable laminate upon the application of a specified tensioning force and dividing that difference by the unextended dimension of the stretchable laminate. If the stretch-to-stop is expressed in percent, this ratio is multiplied by 100. For example, a stretchable laminate having an unextended length of 5 inches (12.7 cm) and a maximum extended length of 10 inches (25.4 cm) upon applying a force of 2000 grams has a stretch-to-stop (at 2000 grams) of 100 percent. Stretch-to-stop may also be referred to as "maximum non-destructive elongation." Unless specified otherwise, stretch-to-stop values are reported herein at a load of 2000 grams. In the elongation or stretch-to-stop test, a 3-inch by 7-inch (7.62 cm by 17.78 cm) sample, with the larger dimension being the machine direction, the cross direction, or any direction in between, is placed in the jaws of a Sintech machine using a gap of 5 cm between the jaws. The sample is then pulled to a stop load of 2000 gms with a crosshead speed of about 20 inches/minute (50.8 cm/minute). For the stretchable laminate material of this invention, it is desirable that it demonstrate a stretch to stop value between about 30-400 percent, more desirably, between about 100-250 percent. The stretch to stop test is done in the direction of extensibility (stretch).

For the purposes of this application, the terms "stretch" and "stretchable" shall mean the ability to be extended without breaking, by at least 10 percent (to at least 110 percent of its initial (unstretched) length in at least one direction, suitably by at least 30 percent (to at least 130 percent of its initial length), or by at least 50 percent (to at least 150 percent of its initial length). In still a further embodiment, such a material is capable of extending by at least between 50-80 percent (to at least 150-180 percent of its initial length). The terms encompass elastic fabric materials as well as fabric materials that may be extendable, but do not significantly retract. A hypothetical example which would satisfy this definition of an extendable fabric material would be a one (1) inch sample of a material which is elongatable by at least 30 percent to at least 1.30 inches. Such elongation may be the result of properties of the raw materials making up the fabric material, structural geometry of the fabric material, or a combination of both.

An in-line manufacturing method can be used to produce a topographed film (raised surface textured) or netting fabric structure for use either alone or in conjunction with other sheet materials for various end product applications. In one embodiment, such topographed film provides topography to a nonwoven laminated thereto. In an alternative embodiment, such netting material provides a support layer to one or more nonwoven material layers. Desirably such film or netting fabric is extensible and demonstrates the ability to stretch, such as in one, but desirably in at least two perpendicular directions, such as the MD and CD direction. Even more desirably, such film or netting is elastic, in that it recovers much, if not all of its stretch after a biasing force is removed. The ability of the film or netting to stretch is dependent upon both the structural geometry of the film or netting material and also the polymers making up the film or netting material. For the purposes of this application, the term "netting" shall refer to an open meshed fabric. Also, for the purposes of this application, the term "open" shall refer to a space in a sheet defined by polymer material positioned in generally the "X" and "Y" directions (X-Y plane). That is, if the netting fabric/material is held flat in a horizontal position, the length and width of the fabric would be described as the "X" and "Y" directions". The "Z" direction would be the depth/thickness, essentially, the vertical direction into the fabric. Exemplary netting is illustrated in Fig. 2A showing spaces in a mesh/netting material, through which a layer below the netting can be seen. The Figure illustrates a netting and nonwoven material laminate. The X, Y, and Z directions are illustrated in such Figure.

In one embodiment, the topographed film or netting of the invention is laminated to further layers while the film or netting material not under tension. For instance, such topographed film or netting may be part of a necked bonded laminate. Such resulting

laminate may be utilized for a support layer or fluid transfer layer. In another alternative embodiment, the film or netting is in a stretched state (under tension) when it is laminated to further layers. For instance, such film or netting may be part of a stretch bonded laminate, with the film or netting serving as an elastic layer. The further layers may include
5 nonwoven materials. Such lamination in some embodiments induces corrugations/gathering in the nonwoven layers, after the tension is removed from the film or netting. The laminate material may then be used as an extensible or elastic base fabric, as a liquid transfer fabric, or as a combination of both. Such gathered laminate will provide a textured fabric that may be desirable in some end product applications, such as
10 outer covers in personal care products. In a further alternative embodiment, such film or netting material is bonded to at least one necked nonwoven layer (such as a spunbond) such that the produced laminate demonstrates CD stretch. In still a further alternative embodiment, a necked nonwoven layer is bonded to each side of such film or netting material. In still a further alternative embodiment, such laminate is a stretch necked
15 bonded laminate, in that the elastic film or netting material is bonded to a necked nonwoven layer. In still a further alternative embodiment, such netting material provides a structural support for a nonwoven web, which combination can be used as a filter material.

As can be seen, a method 10 for producing such "topographied" film or netting material is shown generally in schematic as Fig. 1. While the method is shown in a
20 horizontal configuration, it should be appreciated that the method may be alternatively arranged in a vertical configuration or include only certain portions that are in a vertical configuration and others which are in a horizontal configuration. In some instances, production steps would more appropriately be positioned in one configuration or the other. The method includes as a first step, the extrusion of a film from a film die 15. Such film
25 may be produced via either a cast film or blown film method, although a cast film is desirable. If a film is produced using a blown method, the remaining process steps would likely follow a machine direction orientor used after the film has been blown and extended. In any event, a traditional resin hopper or hoppers (not shown) would feed the film die 15, via an optional melt pump for uniform flow (also not shown). A melt pump is not required,
30 however, as the polymer resin may pass directly from an extruder to a film or sheet die. The film die would likely extrude the resin pellets into film at a temperature of between about 360 and 450° F depending on the polymer to be extruded. Desirably, such film die would extrude a film at a temperature between about 380 and 420° F depending on the polymer properties. Standard extrusion pressures, as are known in the art would be used
35 to extrude the film from the die. Desirably, the polymers to be extruded have a melt flow

rate (using 230 °C, 2.16kg conditions) of between about 2g/ 10 min and 50g/ 10 min, generally in accordance with ASTM D1238.

A variety of polymers may be utilized in the process to impart desired features in the final film or netting material. Materials suitable for use in preparing the "topographed" film or netting material include neat polymers, a mixture of polymers as "compounds," as well as tackified polymers or compounds. More specifically, an elastomeric film or netting may include diblock, triblock, tetrablock, or other multi-block elastomeric copolymers such as olefinic copolymers, including ethylene-propylene-diene monomer (EPDM), styrene-isoprene-styrene (SIS), styrene-butadiene-styrene (SBS), styrene-ethylene/butylene-styrene (SEBS), or styrene-ethylene/propylene-styrene (SEPS), or compounds of these elastomeric block copolymers, which may be obtained from the Kraton Polymers of Houston, Texas, under the trade designation KRATON elastomeric resin, or from Dexco Polymers, under the trade designation VECTOR, polyamides, including polyether block amides available from Ato Chemical Company, under the trade name PEBAX® polyether block amide; polyesters, such as those available from E. I. Du Pont de Nemours Co., under the trade name HYTREL polyester; polyisoprene; cross-linked polybutadiene; and single-site, constrained geometry or metallocene-catalyzed polyolefins typically having a density less than about 0.89 grams/cubic centimeter, available from Dow Chemical Co. under the trade name AFFINITY, or a similar material available from ExxonMobil Corporation under the trade name EXACT.

A number of other block copolymers and compounds of these copolymers can be useful to prepare the film or netting. Such block copolymers generally include an elastomeric midblock portion B and a thermoplastic endblock portion A. The polymers and block copolymers should also be thermoplastic in the sense that they can be melted, formed, and resolidified several times with little or no change in physical properties (assuming a minimum of oxidative degradation).

Endblock portion A may include a poly(vinylarene), such as polystyrene. Midblock portion B may include a substantially amorphous polyolefin such as polyisoprene, ethylene/propylene polymers, ethylene/butylenes polymers, polybutadiene, and the like, or mixtures thereof.

Suitable block copolymers may include at least two substantially polystyrene endblock portions and at least one substantially ethylene/butylene mid-block portion. A commercially available example of such a block copolymer is available from Kraton Polymers under the trade designation KRATON G1657 elastomeric resin. Another useful G resin includes KRATON G 1730. Other suitable elastomeric compounded resins include KRATON G 2755 or 2760. Additionally, blends can be used or blends with fillers

and/or processing aids as are known in the art. Such fillers may provide other benefits, such as serving as a heat sink during the process, or imparting desirable physical attributes to the material.

Such polymer materials would provide either no extensibility, or limited extensibility
5 in the final topographed film or netting material, as a result of the structural geometry of the netting and limited polymer benefits (such as the single-site catalyzed materials), but would not necessarily offer desired elasticity or, in still a further alternative embodiment depending on polymer choice, would also offer a more elastic material (such as if a styrenic block copolymer was utilized).

10 Once the desired polymer, polymers, or blends is selected, the film is extruded, desirably to a gauge of between about 1 mil and 20 mil, more desirably between 2 mil and 20 mil, prior to entering the nip. Alternatively the film is extruded to a gauge (thickness) of between about 2 and 10 mils, or between about 2 and 7 mils. It should be recognized that the film, rather than be extruded directly to the nip, can be provided from an offline
15 supply roll to the nip. The gauge of the offline film would in one embodiment be similar to those ranges previously described. Following film extrusion, the film 20 is passed to a nip 25 formed between two rolls, 30 and 35, such as a flat surfaced roll and a patterned roll. One or both of the rolls can be chilled somewhat, if the film is to be patterned immediately following extrusion. If the film is provided from an offline process, in a room temperature
20 state, one or both rolls can be heated to soften the film while it is being patterned. If a chill roll is provided, the chill roll nip includes at least one, but desirably two chilled rolls 30 and 35 which are chilled to between 60-150° F. The chill rolls may be chilled by being fluid cooled. If rolls are to be heated (as previously described), it is desirable to heat one or both to between about 210° F and 350° F enough to just soften the film and emboss the
25 pattern. It is theorized that such embossment pushes polymer from the patterned areas to the unpatterned areas (from a high pressure area to a low pressure area).

Desirably, the nip pressure is sufficient to leave an indentation in the film that corresponds to patterns on the patterned roll. Such indentations create the surface
topography of the film. The nip pressure is desirably between about 100 psi and about
30 1000 psi. In an alternative embodiment, the nip pressure is between about 250 and 500 psi (as measured at the nip).

In one embodiment, the patterned roll includes a raised pattern about its surface, of such raised height/depth as previously described with regards to pattern bonding rolls. Such pattern may be a series/pattern of raised discontinuous lines, either curvilinear or
35 linear, that are elongated across the roll (that is from one end of the roll to the other as seen for example in Fig. 3A). Alternatively, such pattern may be a series/pattern of closely

spaced points, separated by larger areas of recess. However, the desirable closely spaced point patterns are such that they are in the form of a larger shape, such as an oval or polygon that is also elongated in a direction from one end of the roll to the other. Still in a further alternative embodiment, such raised pattern is in the form of a series of closed shapes. For the purposes of this application, the term "closed shape" is defined to mean a shape which completely and continuously encloses/encircles a given area. Such a shape may be for example, a polygon, circle, oval, square, rectangle, triangle or any free-form, curvilinear or linear walled shape. Such closed shape may be defined by a raised outline pattern of the shape, or a raised solid shape. Essentially, the desired pattern of the nip creates a pattern of indented topographical shapes within the film that enclose areas/surface spaces along the surface of the film. Such shapes project outward from the film. In desired embodiments, the surface spaces are indented circular shapes or boxlike shapes (indentations). The terms "raised" or "indented" shall be used synonymously and refer to the shapes after they have been formed in the film, such that they project from much of the surrounding surface of the film. It should be understood that such raised areas can in fact be recesses in the surface of the film, depending on the perspective by which the film is viewed. These shapes are three dimensional in nature, as they create areas in the film with thinned portions corresponding to the locations where the raised roll patterns contact the film, and thicker portions corresponding to the locations where the nonraised areas of the pattern fail to contact, or minimally contact the film.

As previously stated, the patterns may be mere outlines of closed shapes, such as diamonds or circles, or desirably, the patterns will be solid raised area shapes with the entire closed shape areas consisting of a raised portions on the rolls. Each of these respective raised areas is illustrated in the figures which are described further below. The darkened areas in the figures correspond to the raised areas of the pattern rolls and the lighter areas correspond to the recessed areas of the patterned rolls. Desirably, the closed shape roll patterns are discontinuous, separated by areas of continuous recess on the patterned roll surface.

In one embodiment, the indentation area in the film, formed by the raised patterned rolls, is between about 8 and 60 percent of the film surface. In a further embodiment the indentation area in the film is between about 8 and 30 percent. In an alternative embodiment, each of the individual raised pattern shapes on the pattern roll is separated by continuous recess channels having a thickness of between about one sixteenth to a quarter of an inch in width. It should be recognized that a pattern roll may have multiple pattern shapes and any number of shapes, so long as the number does not lead to the collapse of a formed netting, as explained below. Larger roll pattern shapes,

orientation of shapes in specific directions, and too numerous shapes may lead to larger netting material openings and subsequent netting failure, depending on the pattern geometry and film polymer composition.

In one embodiment, the pattern and anvil rolls are each of metal construction and are cooled only sufficiently to start quenching the film (assuming the film is immediately provided from an extrusion die). The film should not be quenched such that the rolls do not leave a topographical impression/indentation in the film. The rolls are desirably hot enough to cause the softened film to flow somewhat, to take on the desired three dimensional, cup-like shapes. While not necessary, it is desirable that there be slight tension between the extruder or offline film feeding roll, and the roll nip during the process, in order to keep the film from sagging, but not enough tension to cause a break in the film or rupture in the film at the pattern areas. In a further alternative embodiment, the rolls include about one inch at each end for loading of the film. Desirably the rolls are independently driven utilizing known technology. Also, in an alternative embodiment, it is desirable that the rolls include a non-stick finish, such as a PTFE (TEFLON of DuPont), silicone rubber, or other such treatment.

As seen in Figures 3A-3E, which are not drawn to scale, the rolls of the nip include in one embodiment only one patterned roll and one flat surfaced anvil roll. For the purposes of this application, the term "flat surfaced" shall be used synonymously with smooth surfaced and plain surfaced, to indicate that the surface of the roll does not include any raised or recessed portions. One or both of the rolls may be of a metal or rubber construction, such as a nylon (as in nylon 6) construction, or alternatively a rubber construction having a relatively high shore hardness value such as a shore D rating of about 50. Such nylon is exemplified by DELRIN (of Dupont) rolls. In an alternative embodiment, the rolls each include non overlapping raised patterns, (i.e. the patterns on each of two rolls are offset/intermeshing) such as those patterns previously described. In this fashion, the produced topographed film will include topography on both sides, but in a repeating overall pattern.

In one alternative embodiment, the patterned roll includes discontinuous crescent shapes across its surface, from one end of the roll to the other. As can be seen in Fig. 3A, a nip roll arrangement is illustrated 230, in which one roll is patterned with crescent shapes 235, and the second roll is a flat surfaced anvil roll 240. A film is illustrated 242 entering the nip of the rolls. While the pattern is not shown across the entire surface of the roll 235, it should be understood that such pattern may cover as much of, or as little of the surface as is desired. Alternatively, various patterns may be incorporated onto a single roll. The crescent shapes are generally aligned from one end

of the roll to the other (in the CD direction) and are somewhat elongated. A continuous recess separates the raised crescent shape pattern.

It should be emphasized that for this figure and the figures that follow, the darkened lines or areas in the figures are representative of raised surfaces, while the light background is representative of recessed areas on the roll surface.

Additional patterns are contemplated to be within the scope of the invention. For example, while not wishing to be limiting, a series of diamonds may be positioned along a surface of the patterned roll. As can be seen in Fig. 3B, a series of solid elongated diamonds (elongated in the CD direction) are situated on a patterned roll 255 of a nip roll arrangement 250. A flat surfaced anvil roll 260 may be used in conjunction with the elongated diamond patterned roll. For illustration, a closed shape diamond that is not entirely raised, but formed from an outer wall, is also illustrated as 256. Similarly, a series of rounded edged shapes, such as ovals may be positioned across a patterned roll. As can be seen in Fig. 3C a nip 270 is formed between an elongated oval patterned roll 275 and a flat surfaced anvil roll 280. As in 3B, a closed shape oval defined by a raised outer wall 276 is also shown. As another example, a series of elongated box-like shapes can be used to create a raised pattern on a roll surface. As can be seen in Fig. 3D, a series of raised rectangular shaped patterns appears across the surface of patterned roll 290. It should be recognized that in each of the previous respective patterns, it is desirable that the various patterns each have an exaggerated and elongated cross direction dimension. As can be seen in Fig. 3D, the rectangles are clearly elongated in the cross-direction 294 dimension, when compared with the machine direction 292 dimension. Such elongation is also seen in the respective ovals and diamonds previously described. The elongation of such shapes in the cross machine direction allows such shapes on the film to open up in the machine direction, when stretched and heated, as will be described below. If such shapes were instead elongated in the machine direction, it is likely that such shapes would lead to a material, which might not produce an open netting at the conclusion of the process.

The above shapes and patterns are not meant to be limiting and it is envisioned that a whole array of pattern shapes could be utilized in the practice of this invention. For instance, hexagonal and octagonal shapes can also be utilized. In one embodiment, it is desirable that patterns be utilized that reduce stress/failure points in a final netting material. In such a manner, circular or rounded shapes would be desirable, as would shapes with increasingly larger obtuse angles between their sides (such as honeycomb/hexagonal, octagonal or other larger polygonal shapes). Desirably in one embodiment, the raised patterns include rounded edges such that the film is not unduly torn or ripped as

it passes through the nip rolls 30, 35. Finally, in a further alternative embodiment, as can be seen in Figure 3E, the raised shapes on the pattern roll may consist of closely spaced points, that together form discontinuous outlines of closed spaces, such as elongated ovals 210. Such shape outlines are themselves separated by relatively large expanses of recesses.

Following three dimensional topographical pattern formation in the film, the film may be laminated to a variety of materials such as nonwoven materials (either single layered or laminate materials). Such topographed film and nonwoven laminate can be inelastic. In an alternative embodiment, such laminate may be extensible, or suitably demonstrate stretch in multiple directions. In still a further alternative embodiment, such laminate may be elastic. Such laminate desirably includes a corrugated or textured surface, reflecting the textured surface of the film. Such lamination may occur using thermal, adhesive or ultrasonic bonding techniques. Additionally, such lamination may occur with the film under tension, or with a necked nonwoven material, or a combination of such. Essentially, the three dimensional pattern in the film provides structural geometry to provide texture and in some instances, to allow "give" in the film in multiple directions. Additionally, any elasticity resulting from the film polymer itself also contributes to the overall material elasticity. If the film is under tension, the lamination of the film to another layer such as an extensible or elastic nonwoven, can create a stretch bonded laminate. The term "stretch bonded laminate" refers to a composite elastic material made according to a stretch bonding lamination process, i.e., elastic layer(s) are joined together with additional layers when only the elastic layer is in an extended condition so that upon relaxation of the layers, the additional layer(s) is/are gathered. Such laminates usually have machine directional stretch properties and may be subsequently stretched to the extent that the additional (typically nonelastic) material gathered between the bond locations allows the elastic material to elongate in the machine direction. One type of stretch bonded laminate is disclosed, for example, by U.S. Patent No. 4,720,415 to Vander Wielen et al., in which multiple layers of the same polymer produced from multiple banks of extruders are used. Typically, the elastic layer is bonded in a stretched condition to an inelastic or extendable facing material (such as a nonwoven material), such that the resulting laminate is imparted with a textural feel that is pleasing on the hand. In some instances, the gatherable layer may also be necked, such that the stretch bonded laminate is actually a neck-stretch bonded laminate. Therefore, in one embodiment, such nonwoven material may be a necked spunbond material.

A formed (topographed) film can be seen in Fig. 2 which illustrates a perspective view of a patterned film made in accordance with the inventive method. As can be seen in

the drawing, the film 91 includes raised portions 92 (or indentations depending on a viewer's perspective), which correspond to the raised portions on a patterned roll (in this case a box or rectangular patterned roll). The film also includes flattened/thinned areas 93, which correspond to the raised portions on the pattern roll. Thicker film areas surround the raised film portions. In one embodiment, it is desirable to bond the topographed film to the nonwoven with the raised surface of the film facing the nonwoven and the heating element/plate or roll (in a thermal bonding arrangement) facing the film only. In this situation an anvil surface can be positioned behind the nonwoven material.

Referring again to Fig. 1, in an alternative embodiment of the process, following the film's passage through the pattern roll nip 25, the film may pass to a heating unit which provides heat/hot air, which is allowed to pass over the film. The film is desirable maintained under tension as it passes the hot air supply. Such hot air may be provided by a directional heat radiating device or a hot air knife (HAK) 45, which delivers hot air over the film. An air knife is a device known in the art which focuses a stream of air at potentially a very high flow rate to the edges of the extruded polymer material.

Specifically, a hot air knife is a device which can focus a stream of heated air at a very high flow rate, generally from about 1000 to about 10000 feet per minute (fpm) (305 to 3050 meters per minute), or more particularly from about 3000 to 5000 feet per minute (915 to 1525 m/min.) directed at the film. The air temperature is usually in the range of the melting point of at least one of the polymers used in the film or slightly above, generally between about 200 and 550 degree F (93 and 290 degree C) for the thermoplastic polymers commonly used in film formation. In some embodiments, a low air flow rate would be desirable, so as to eliminate unnecessary damage to the film. Such a low flow rate would be less than about 100 feet per minute.

The control of air temperature, velocity, pressure, volume and other factors helps avoid damage to the film. The HAK's focused stream of air is arranged and directed by at least one slot of about 1/8 to 1 inch (3 to 25 mm) in width, particularly about 3/8 inch (9.4 mm), serving as the exit for the heated air towards the film, with the slot running in a substantially cross-machine direction over substantially the entire width of the film. In other embodiments, there may be a plurality of slots arranged next to each other or separated by a slight gap. The at least one slot is usually, though not essentially, continuous, and may be comprised of, for example, closely spaced holes. The HAK has a plenum to distribute and contain the heated air prior to its exiting the slot. The plenum pressure of the HAK is usually between about 1.0 and 12.0 inches of water (2 to 22 mmHg), and the HAK is positioned between about 0.25 and 10 inches and more commonly 1.0 to 5.0 inches above the film. In a particular embodiment the HAK plenum's cross sectional area for

cross-directional flow (i.e. the plenum cross sectional area in the machine direction) is at least twice the total slot exit area. Since the film formation generally moves at a high rate of speed, the time of exposure of any particular part of the film to the air discharged from the hot air knife is in one embodiment less than 2 seconds, suitably less than one second, in an alternative embodiment less than a tenth of a second and generally about a hundredth of a second. The HAK process has a great range of variability and controllability of many factors such as air temperature, velocity, pressure, volume, slot or hole arrangement and size, and the distance from the HAK plenum to the film.

In an alternative embodiment a vacuum supply 51 is positioned on the side of the film opposite the hot air supply, to draw it away from the film 40, as it passes through the formed netting. Essentially, a vacuum may assist in moving the polymer from the thin film areas to the thicker side areas, that will eventually make up the netting structure. The film may be traveling on a foraminous surface, or may be positioned in a tension state away from a foraminous surface such that the tension keeps the film elevated between processing stations. It should be recognized that the hot air may be directed from either side of the film. The film is maintained under tension by being held between the first nip 25 and a second nip 55. Such configuration should be sufficient to keep the film taut, but not to break or tear it. The temperature of the hot air supply will depend on the film polymer utilized. Desirably, in one embodiment, the temperature of the hot air supply will be between 25-50° F above the melting point of the film polymer. In one embodiment, the distance of the hot air supply is desirably between about 1 and 5 inches above the film. In an alternative embodiment, the hot air supply is about 2 inches above the film, and the velocity of the air from the hot air supply is desirably fast enough to create holes in the film at the pattern points (i.e. the shapes in the topography of the film) but not to rupture the film in its entirety. The use of the term "pattern points" is meant to describe the thinned portions of the film i.e. 93 of Fig. 2, resulting from the pressure of the patterned roll(s) on the film and anvil rolls. The dwell time of the film under the heated air supply is desirably in one embodiment less than 2 seconds. In a second alternative embodiment, the dwell time is less than about 1 second. In still a further alternative embodiment, the dwell time is between about a hundredth of a second and a tenth of a second.

After leaving the heated air supply, the material is directed to a second nip 55. The material, however, is no longer a film, but has become a netting, as a result of the heating/ melting of the film at its thinnest pattern points. The polymer in the film that was positioned in the thinned patterned areas has melted and/or has flowed to the sides of the patterned areas, thereby increasing / strengthening the polymer mass in those areas. These side areas make up the strands/sections of the netting material. As a result, a

material with a series of open holes/spaces has been created, effectively forming a netting/mesh. As a result of the MD tension applied to the film as it passed over the heat, and the elongated CD pattern shapes, the open spaces are easily formed in the MD direction of the film. If the patterns are comprised of points that form an outline of a larger shape (such as in Fig. 3E), the combination of melting points cumulatively forms a series of large openings, as all of the polymer mass flows to the sides of the larger discontinuous outlined shape. Such openings are comparable to those openings formed via walled or solid pattern shapes.

Following such netting formation, the netting may be wound for later use if desired or alternatively, moved to a secondary in-line process, such as treatment with a surfactant, or incorporation into a multilayered material structure. For instance, such netting may be adhesively, thermally, or ultrasonically bonded into a second or multilayered material. In one such embodiment, the netting is fed under tension to an extensible or necked nonwoven and bonded using any of the previously described methods.

Alternatively, such netting material may be combined with one or more additional materials in a single nip 55, either with or without tension. For example, the netting may be directed to the second nip, which maintains the netting under tension between two additional rolls 60 and 65. One or both of such rolls are desirably chilled to between about 60-80° F. Such rolls are either operating at the same speed or slightly higher speed than those of the previous nip 25. Such higher level of speed causes the spaces in the netting to open in the MD direction. To create the necessary tautness, in one embodiment, the second nip rolls 60 and 65 operate at a higher speed that is less than one percent higher than the speed of the first nip roll set 30, 35. As with the previous rolls, such second nip rolls 60 and 65 may be metal in construction, and are desirably non-patterned/smooth along their surfaces. In an alternative embodiment, such rolls may be of a rubber construction, as previously described.

As seen in Fig. 1, which illustrates a nip 55 of two chill rolls 60 and 65, one or more in-line or preformed sheet materials or nonwoven materials may be joined to the netting material. As seen in the Figure, a first nonwoven material 75 may be unwound from a first roll 70, and a second nonwoven material 85 may be unwound from a second roll 80. Such nonwoven materials may be bonded to the netting material in the nip such that they are positioned on opposite sides of the netting material. Such nonwovens may be applied to the netting by various bonding systems, such as adhesive systems which apply adhesive to the surface of the nonwoven 86, or other of the previously described bonding systems. Alternatively, the polymers in either the netting material or the outer

nonwoven materials, may also include a tackifier, such that pressure between the nip rolls is sufficient to bond the materials together through adhesion. The rolls may themselves be smooth or patterned.

In an alternative embodiment, the nonwoven facing materials 75, 85 may be either single layers or themselves multilayered laminates. Such nonwoven materials may be meltblown, spunbond, coformed, or any other nonwoven sheet described herein. For instance such other materials may be cellulosic, or mixed cellulosic and nonwoven materials, and bonded carded webs. Such nonwoven layers may also be patterned bonded. Additionally, in an alternative embodiment, such nonwoven material may be of a bicomponent/conjugate spunbond material. In still a further alternative embodiment, such nonwoven material may be a necked spunbond material, such as for example, a necked spunbond that has been necked between about 25-60 percent, such that it stretches in the CD direction. In such a fashion, the final laminate structure can demonstrate bidirectional stretch attributes, such as if the material is a necked stretched laminated. The nonwoven facing layer may itself be elongatable or elastic, depending on the end product desired. Desirably, if a nonwoven material is laminated to such netting material, it is desirable that the nonwoven material have a basis weight of between about 0.2 and 1.5 osy. In an alternative embodiment, the nonwoven material has a basis weight of between about 0.3 and 0.7 osy. In still a further alternative embodiment, the nonwoven material is necked prior to being bonded with the netting. In still a further alternative embodiment, the nonwoven material is necked between about 25 and 60 percent. Such nonwoven material facing layer is desirably a polypropylene spunbond material. The produced netting material itself in one embodiment has a final basis weight of between about 30 gsm and 1000 gsm. In a second embodiment, the netting has a basis weight of between about 30 gsm and 600 gsm. In a third alternative embodiment, the netting has a basis weight of between about 30 gsm and 100 gsm. A facing layer may be applied to either one or both sides of the netting material such that the netting has one or two facing layers.

Following lamination of the netting and nonwoven facing materials, the materials may be further processed in-line, or alternatively wound on a winder roll 90, for usage at a later date/time. The produced laminate may include either an extensible or elastic netting material depending on final product application. For instance, if no stretch is required, and the netting material merely will serve as a structural component for the nonwoven material and/or to allow fluid transfer (either gas or liquid), then a nonelastic or slightly elastic/extensible thermoplastic polymer may be used for the netting base material. If a more elastic material is desired, then a more extensible or elastic thermoplastic polymer would be desirable for the netting structure. If such stretch is to be provided, through

either the structural geometry or polymer nature of the netting, it is desirable in one embodiment that the netting be able to stretch in at least two directions by an amount of between about 30 and 150 percent from its starting dimension, such that if the material was one inch in length at its start, it would stretch to 1.3 inches in that dimension before breaking.

As can be seen in Fig. 2A, a laminate is illustrated such that the laminate 100 includes a netting layer 120 and a nonwoven layer 130. The nonwoven material can be seen through the openings 110 in the netting structure. The laminate structure demonstrates a corrugated or topographed surface as a result of the netting being applied to the nonwoven or other sheet material, such as in a slightly tensioned state, or as a result of the netting cooling and bunching the nonwoven layer in the space areas. It should be understood however, that the greater the tension under which the netting is placed while being bonded to the facing materials, the greater the amount of corrugation in the resulting netting/facing laminate. The corrugation or gathering which occurs in the laminate is a result of either the elastic netting contracting upon being laminated to the facing layer(s) after the tension is removed, or cooling and shrinking of the netting. It is further the result of the nonwoven facing layer being bonded at discrete points such that it gathers in those areas that are not bonded to the netting, or are situated over the open spaces in the netting.

If the nonwoven material is previously necked and then bonded to the netting while the netting is under tension, such nonwoven material will form gathers and allow stretch and in some instances recovery in multiple directions. Without an additional laminate material, the netting itself in one embodiment, stretches in multiple directions. If a facing is inherently extensible in two directions, it will also provide stretch capabilities to the underlying netting, if the underlying netting also provides stretch capability in multiple directions. It has been found that netting with diagonal or circular openings provides some desirable stretch in two perpendicular directions.

In a further alternative embodiment, the netting and/or laminate may be used to provide a structural component to a residential or commercial filtration material. For example, as is known in the art, air filters have incorporated aluminum or other metallic netting/mesh material within various layers of filter material, so as to provide structural integrity to the filter media. The material of the current invention may be used in place of such aluminum or metallic mesh structure.

In a further alternative embodiment of the invention, the film and/or netting material of the current invention may be used as part of an elastic component and/or liquid

handling component of a personal care product. For instance, such material may be utilized to provide elasticity such as in face masks, surgical gowns, or outdoor coverings.

In one particular embodiment, such material may be useful in providing elastic waist, leg cuff/gasketing, stretchable ear, side panel or stretchable outer covers in
5 personal care product applications. Additionally, such material may be used to provide for liquid transport and elasticity, such as in a liner, surge or other absorbent components of a personal care product. While not meant to be limiting, Fig. 4 is presented to illustrate the various components of a personal care product, such as a diaper, that may take
10 advantage of such elastic and liquid transporting composite materials. Other examples of personal care products that may incorporate such materials are training pants, and feminine care products. By way of illustration only, training pants suitable for use with the present invention and various materials and methods for constructing the training pants are disclosed in PCT Patent Application WO 00/37009 published June 29, 2000 by A. Fletcher et al; U.S. Patent 4,940,464 issued July 10, 1990 to Van Gompel et al.; U.S.
15 Patent 5,766,389 issued June 16, 1998 to Brandon et al.; and U.S. Patent 6,645,190 issued November 11, 2003 to Olson et al., which are incorporated herein by reference in their entirety.

With reference to Fig. 4 the disposable diaper 300 generally defines a front waist section 305, a rear waist section 310, and an intermediate section 315 which
20 interconnects the front and rear waist sections. The front and rear waist sections 305 and 310 include the general portions of the diaper which are constructed to extend substantially over the wearer's front and rear abdominal regions, respectively, during use. The intermediate section 315 of the diaper includes the general portion of the diaper that is constructed to extend through the wearer's crotch region between the legs. Thus, the
25 intermediate section 315 is an area where repeated liquid surges typically occur in the diaper.

The diaper 300 includes, without limitation, an outer cover, or backsheet 320, a liquid permeable bodyside liner, or topsheet, 325 positioned in facing relation with the backsheet 320, and an absorbent core body, or liquid retention structure, 330, such as an
30 absorbent pad, which is located between the backsheet 320 and the topsheet 325. The backsheet 320 defines a length, or longitudinal direction 335, and a width, or lateral direction 340 which, in the illustrated embodiment, coincide with the length and width of the diaper 300. The liquid retention structure 330 generally has a length and width that are less than the length and width of the backsheet 320, respectively. Thus, marginal
35 portions of the diaper 300, such as marginal sections of the backsheet 320 may extend past the terminal edges of the liquid retention structure 330. In the illustrated

embodiments, for example, the backsheet 330 extends outwardly beyond the terminal marginal edges of the liquid retention structure 330 to form side margins and end margins of the diaper 300. The topsheet 325 is generally coextensive with the backsheet 320 but may optionally cover an area which is larger or smaller than the area of the backsheet 320, as desired.

To provide improved fit and to help reduce leakage of body exudates from the diaper 300, the diaper side margins and end margins may be elasticized with suitable elastic members, as further explained below. For example, as representatively illustrated in Fig. 4, the diaper 300 may include leg elastics 345 which are constructed to operably tension the side margins of the diaper 300 to provide elasticized leg bands which can closely fit around the legs of the wearer to reduce leakage and provide improved comfort and appearance. Waist elastics 350 are employed to elasticize the end margins of the diaper 300 to provide elasticized waistbands. The waist elastics 350 are configured to provide a resilient, comfortably close fit around the waist of the wearer.

The film, netting and laminates of the inventive structure are suitable for use as the leg elastics 345 and waist elastics 350. Exemplary of such materials are laminate sheets that either comprise or are adhered to the backsheet, such that elastic constrictive forces are imparted to the backsheet 320.

As is known, fastening means, such as hook and loop fasteners, may be employed to secure the diaper 300 on a wearer. Alternatively, other fastening means, such as buttons, pins, snaps, adhesive tape fasteners, cohesives, fabric-and-loop fasteners, or the like, may be employed. In the illustrated embodiment, the diaper 300 includes a pair of side panels 355 (or ears) to which the fasteners 360, indicated as the hook portion of a hook and loop fastener, are attached. Generally, the side panels 355 are attached to the side edges of the diaper in one of the waist sections 305, 310 and extend laterally outward therefrom. The side panels 355 may be elasticized or otherwise rendered elastomeric by use of elastic laminate made from the inventive netting or film structure laminates. Examples of absorbent articles that include elasticized side panels and selectively configured fastener tabs are described in PCT Patent Application No. WO 95/16425 to Roessler; U.S. Patent No. 5,399,219 to Roessler et al.; U.S. Patent No. 5,540,796 to Fries; and U.S. Patent No. 5,595,618 to Fries each of which is hereby incorporated by reference in its entirety.

The diaper 300 may also include a surge management layer 365, located between the topsheet 325 and the liquid retention structure 330, to rapidly accept fluid exudates and distribute the fluid exudates to the liquid retention structure 330 within the diaper 300. The diaper 300 may further include a ventilation layer (not illustrated), also called a

spacer, or spacer layer, located between the liquid retention structure 330 and the backsheet 320 to insulate the backsheet 320 from the liquid retention structure 330 to reduce the dampness of the garment at the exterior surface of a breathable outer cover, or backsheet, 320. Examples of suitable surge management layers 365 are described in
5 U.S. Patent No. 5,486,166 to Bishop and U.S. Patent No. 5,490,846 to Ellis. Such inventive material may serve as a top sheet (liner), surge layer, liquid retention structure (so as to enclose expanding superabsorbent materials) or other absorbent structure or liquid handling component.

As representatively illustrated in Fig. 4, the disposable diaper 300 may also include
10 a pair of containment flaps 370 which are configured to provide a barrier to the lateral flow of body exudates. The containment flaps 370 may be elasticized with the inventive material. The containment flaps are located along the laterally opposed side edges of the diaper adjacent the side edges of the liquid retention structure 330. Each containment flap 370 typically defines an unattached edge which is configured to maintain an upright,
15 perpendicular configuration in at least the intermediate section 315 of the diaper 300 to form a seal against the wearer's body. The containment flaps 370 may extend longitudinally along the entire length of the liquid retention structure 330 or may only extend partially along the length of the liquid retention structure. When the containment flaps 370 are shorter in length than the liquid retention structure 330, the containment
20 flaps 370 can be selectively positioned anywhere along the side edges of the diaper 300 in the intermediate section 315. Such containment flaps 370 are generally well known to those skilled in the art. For example, suitable constructions and arrangements for containment flaps 370 are described in U.S. Patent No. 4,704,116 to K. Enloe.

The diaper 300 may be of various suitable shapes. For example, the diaper may
25 have an overall rectangular shape, T-shape or an approximately hour-glass shape. In the shown embodiment, the diaper 300 has a generally I-shape. Other suitable components which may be incorporated on absorbent articles of the present invention may include waist flaps and the like which are generally known to those skilled in the art. Examples of diaper configurations suitable for use in connection with the instant invention and which
30 may include other components suitable for use on diapers are described in U.S. Patent No. 4,798,603 to Meyer et al.; U.S. Patent No. 5,176,668 to Bernardin; U.S. Patent No. 5,176,672 to Bruemmer et al.; U.S. Patent No. 5,192,606 to Proxmire et al. and U.S. Patent No. 5,509,915 to Hanson et al. each of which is hereby incorporated by reference in its entirety.

35 The various components of the diaper 300 are assembled together employing various types of suitable attachment means, such as adhesive bonding, ultrasonic

bonding, thermal point bonding or combinations thereof. In the shown embodiment, for example, the topsheet 325 and backsheet 320 may be assembled to each other and to the liquid retention structure 330 with lines of adhesive, such as a hot melt, pressure-sensitive adhesive. Similarly, other diaper components, such as the elastic members 345 and 350, fastening members 360, and surge layer 365 may be assembled into the article by employing the above-identified attachment mechanisms.

The various film and netting materials may be exemplified by the following hand assembled material samples. In the first example, first film formulation materials were made with a raised solid square pattern configuration as a pattern embossment using a Carver Press. The same Carver press was used in the second set of examples. In particular, a Carver Lab Press, model #2112 w heated section and cooling section, and with an effective area of 6 inches by 6 inches was used. The Carver press was from Carver Inc. of Wabash, Indiana. A netting material was subsequently made with spaces formed from the square pattern points in the films as follows.

Example Set 1

A first set of films were made of Kraton G2755 (a styrenic block copolymer compound including a tackifier and processing aid) and Dow Affinity metallocene-catalyzed polyethylene (10 MI, 0.87g/cc) in a ratio of 70:30. The gauge of the film samples was between 5 and 10 mil. The films were cut to 6 by 6 inches and placed in the Carver press between a solid raised square patterned plate (as opposed to an outlined pattern) and a flat plate. Both plates were sprayed with a silicone release spray prior to placement of the film, and the temperature on the press was set to 350° F (but can range between about 200-350° F, or more desirably between about 250-350° F depending on the film polymers). The press applied the pattern plate to the films under two pressure settings of 500 and 1000 psi. The pressure of 500 psi worked well, while the 1000 psi adhesively bonded the plates with the film. In an alternative embodiments, such pressure can be between about 20 psi and 500 psi, depending on the film polymer, such that holes are not produced in the film. Such pressures are measured by the gages on the press.

The plates specifically consisted of a raised solid square pattern and flat surfaced anvil plate. The raised squares were quarter inch by quarter inch on each side, separated by one eighth inch channels across the entire pattern plate. The depth of the channels was about 0.050 inch. Both original plates were of metal (aluminum) construction. Additional patterned plates were utilized of nylon construction. After compression, the two plates with the film sandwiched between them, was immediately removed and placed in

the cooling portion of the press. Following cooling at about 50° F, the film was removed (those samples that could be at 500 psi) and the raised square pattern points were visually observed in the film.

Following pattern formation, the film was exposed to stretching by hand, and a
5 heating for 1-2 seconds. A heat gun model # 750, 14 amp, 120 v of MHT Products Inc. was used to expose the patterned films to heat. The square pattern was observed to open up, thereby forming a netting material with regular elliptical shaped openings. The netting material was then observed to be stretchable in multiple directions. The netting also demonstrated retraction. The produced netting had approximately four openings per
10 square inch.

Example Set 2

In a second set of examples, the same polymer materials as previously described
15 were filled with a filled- concentrate (of calcium carbonate in polyethylene). The filler concentrate was let down into the resins of Kraton and Affinity in a ratio, of 40:60, concentrate to resins. The film was extruded at between 165° C (325° F) to 220° C (430° F), at about 600 psi. The film was extruded using a Leistritz ZSE 27 mm twin screw extruder out a die and onto a 14 inch diameter chill/heated roll, coated with a nonstick
20 surface. The gauge of the film was between 5-10 mils.

These films were successfully patterned on the previously described Carver press, at both the 500 psi and 1000 psi levels and under the conditions described above. Netting was then successfully made from these patterned films. A heat gun as previously described, was used to expose the patterned films to heat for about 1-2 seconds. As with
25 the previous examples, pattern plates were nylon (6), and flat anvil plates were aluminum. The anvil plates were one quarter inch thick in each example described above.

It should be appreciated that such film, netting and film and netting nonwoven laminate materials may likewise be used in personal care products, protective outerwear, protective outdoor coverings and the like. Use of such materials provide acceptable
30 bidirectional extensibility and elastic performance along with fluid transport capability.

These and other modifications and variations to the present invention may be practiced by those of ordinary skill in the art, without departing from the spirit and scope of the present invention, which is more particularly set forth in the appended claims. In addition, it should be understood that aspects of the various embodiments may be
35 interchanged both in whole or in part. Furthermore, those of ordinary skill in the art will

appreciate that the foregoing description is by way of example only, and is not intended to limit the invention so further described in such' appended claims.